Slim-Hole Neutron and Gamma Probes

The Challenge

Hanford double-shell waste tank SY-101 is one of the site's most pressing safety concerns. Its concentrated waste generates higher than average gas volumes, most of which is flammable or explosive. The waste surface has been rising at a faster-than-normal rate since early in 1997 and is approaching the maximum allowable tank level. The reasons for this accelerated surface growth are not fully understood and it is not known whether the slurry level is remaining relatively constant and only the crust is expanding, or if the entire waste volume is growing. It is known, however, that there is a surface crust overlaying a foamy, gaseous layer. This gaseous layer rests on top of the liquid waste slurry but, because of the gaseous crust, the exact depth of the liquid slurry cannot be directly measured by conventional means. It is very difficult to measure the true liquid level in the tank or the resulting thickness of the gaseous crust. Resolving these safety issues and preparing to safely transfer the waste out of the tank depends on resolving these issues.

Tank Farm operator inserting probe in MIT. The probe is connected by a combination steel-support and data transmission cable to the LOW van (background) containing data-logging equipment.

Current Approach

The conventional method for measuring tank waste liquid levels below a solid crust employs a neutron and gamma probe that is inserted into a Liquid Observation Well (LOW). The LOW is a hollow fiberglass tube sealed at the bottom that is inserted into the waste, providing an uncontaminated environment to perform waste volume surveys. From the probe response, one can determine the liquid interface within the waste structure, along with other important tank features of interest. Surveillance vans capable of obtaining both neutron and gamma probe data are currently used in about 60 tanks. Unfortunately, SY-101 was not fitted with a LOW and one could not be installed because of overriding safety concerns. There are a limited number of tank riser openings available for new instruments in this tank. There are, however, two existing Multi-Instrument Trees (MITs), installed in the tank. The MITs are about four inches in diameter, with a two-inch hollow center opening that is sealed at the bottom. A "validation probe" can be inserted into the center of the MIT, providing a relatively accurate temperature profile. Since the vapor space and gaseous crust are cooler than the liquid waste, two distinct temperature trends can be identified, and the intersection of these two trend lines approximates the actual liquid slurry level. Measurements with validation probes are time consuming and the probes are expensive to install and remove. This method provides only a rough estimate of the liquid slurry level based on the resulting temperature trend.

Benefits and Features

- 100% compatible with existing equipment
- Accurately tracks waste profile changes
- Faster, more accurate, and less expensive than previous methods

New Technology

The interior opening of the MIT is similar to a LOW, although much smaller. The neutron and gamma probes used in routine LOW logging could provide the waste and liquid interface information needed, but they are too large to fit into the MIT. The builder of the original LOW surveillance equipment, Greenspan Inc., Houston, Texas, was contracted to build slim-hole versions of the probes that would be 100% compatible with all the existing surveillance equipment and software, but having an outside diameter to fit the narrow opening in the MIT. The new probes generate slightly lower count rates than the full size versions; however, the nuclear statistics meet monitoring requirements without compromising data accuracy or sensitivity.

The new equipment is compatible with the existing equipment to the extent that the operating procedures do not need to be modified. The data from the new probes clearly identified the top of the liquid slurry, the location of the tank bulkhead spacing rings, the gaseous interval just above the liquid, and the elevation of the surface crust. Surveys are being conducted weekly to track changes in the waste profile features, and the accuracy of the measurements is greatly improved and less expensive than the previous validation probe method. The new probes are providing critical information helping to resolve the important tank waste volume safety issue. This technology also will enable continued planning for the pumping of tank waste and lowering the surface to a safer level.

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